

WHAT IS CLAIMED IS:

- 1 **1.** A computer-assisted method comprising:
2 accessing stored volumetric (3D) imaging data of a subject;
3 representing at least a portion of the 3D imaging data on a two dimensional
4 (2D) screen;
5 receiving user-input specifying a single location on the 2D screen;
6 computing an initial centerline path of the tubular structure;
7 obtaining segmented 3D tubular structure data by performing a segmentation
8 that separates the 3D tubular structure data from other data in the 3D imaging data
9 using the single location as an initial seed for performing the segmentation; and
10 correcting the initial centerline path using the segmented 3D tubular
11 structure data.

- 1 **2.** The method of claim 1, further comprising incrementally extracting from the
2 3D imaging data a central axis path of the tubular structure.

- 1 **3.** The method of claim 2, in which the performing the segmentation further
2 comprises:
3 initializing a front at an origin that is located along the central axis path;
4 initializing a propagation speed of evolution of the front to a first value;
5 propagating the front by iteratively updating the front, the updating
6 including recalculating the propagation speed;
7 comparing the propagation speed to a predetermined threshold value that is
8 less than the first value;
9 if the propagation speed falls below the predetermined threshold value, then
10 terminating the propagating of the front; and
11 classifying all points that the front has reached as pertaining to the tubular
12 structure.

1 **4.** The method of claim 1, further comprising:
2 initializing at least one parameter of a segmentation algorithm;
3 iteratively performing the segmentation of 3D tubular structure data for
4 separating the 3D tubular structure data from other data in the 3D imaging data, the
5 iteratively performing the segmentation including iterating the segmentation
6 algorithm; and
7 reinitializing the at least one parameter between iterations of the
8 segmentation algorithm, the reinitializing including adjusting the at least one
9 parameter to accommodate a local variation in data associated with the tubular
10 structure.

1 **5.** The method of claim 1, further comprising:
2 computing a central vessel axis (CVA) of the segmented 3D tubular
3 structure;
4 representing a 3D image of a region near the segmented 3D tubular on a two
5 dimensional (2D) screen;
6 displaying on the screen a first lateral view of at least one portion of the
7 segmented 3D tubular structure, the first lateral view obtained by performing curved
8 planar reformation on the CVA of the segmented 3D tubular structure;
9 displaying on the screen a second lateral view of the at least one portion of
10 the segmented 3D tubular structure, the second lateral view taken perpendicular to
11 the first lateral view;
12 displaying on the screen cross sections, perpendicular to the CVA; and
13 wherein the 3D image, the first and second lateral views, and the cross
14 sections are displayed in visual correspondence together on the screen.

1 **6.** The method of claim 1, further comprising masking data that is outside of
2 the 3D tubular structure.

1 **7.** The method of claim 1, further comprising computing at least one estimated
2 diameter of the segmented 3D tubular structure.

1 **8.** The method of claim 7, further comprising flagging at least one location of
2 the segmented 3D tubular structure, the at least one location deemed to exhibit at
3 least one of a stenosis or an aneurysm.

1 **9.** The method of claim 7, further comprising displaying the segmented 3D
2 tubular structure using a color-coding to indicate the diameter.

1 **10.** The method of claim 1, further comprising displaying the segmented 3D
2 tubular structure in a manner that mimics a conventional angiogram.

1 **11.** A computer-readable medium including executable instructions for
2 performing a method, the method comprising:
3 accessing stored volumetric (3D) imaging data of a subject;
4 representing at least a portion of the 3D imaging data on a two dimensional
5 (2D) screen;
6 receiving user-input specifying a single location on the 2D screen;
7 computing an initial centerline path of the tubular structure;
8 obtaining segmented 3D tubular structure data by performing a segmentation
9 that separates the 3D tubular structure data from other data in the 3D imaging data
10 using the single location as an initial seed for performing the segmentation; and
11 correcting the initial centerline path using the segmented 3D tubular
12 structure data.

1 **12.** A computer-assisted method comprising:
2 accessing stored volumetric (3D) imaging data of a subject;
3 initializing at least one parameter of a volumetric segmentation algorithm;

4 iteratively performing a segmentation to separate 3D tubular structure data
5 from other data in the 3D imaging data, the iteratively performing the segmentation
6 including iterating the segmentation algorithm; and
7 reinitializing the at least one parameter between iterations of the
8 segmentation algorithm, the reinitializing including adjusting the at least one
9 parameter if needed to accommodate a local variation in the 3D tubular structure
10 data.

1 **13.** The method of claim 12, further comprising:
2 receiving user input specifying a single location;
3 computing a central vessel axis (CVA) path using the single location as an
4 initial seed; and
5 wherein the iteratively performing the segmentation includes using the CVA
6 path to guide the segmentation.

1 **14.** The method of claim 12, further comprising:
2 automatically computing a single location to use as an initial seed;
3 computing a central vessel axis (CVA) path using the automatically
4 computed single location as the initial seed; and
5 wherein the iteratively performing the segmentation includes using the CVA
6 path to guide the segmentation.

1 **15.** The method of claim 14, in which the automatically computing the single
2 location comprises using a stored atlas of 3D imaging information to obtain the
3 single location.

1 **16.** The method of claim 12, further comprising masking data that is outside of
2 the 3D tubular structure.

- 1 **17.** The method of claim 12, further comprising computing at least one
2 estimated diameter of the segmented 3D tubular structure.
- 1 **18.** The method of claim 17, further comprising flagging at least one location of
2 the segmented 3D tubular structure, the at least one location deemed to exhibit at
3 least one of a stenosis or an aneurysm.
- 1 **19.** The method of claim 17, further comprising displaying the segmented 3D
2 tubular structure using a color-coding to indicate the diameter.
- 1 **20.** The method of claim 12, further comprising displaying the segmented 3D
2 tubular structure in a manner that mimics a conventional angiogram.
- 1 **21.** A computer readable medium including executable instructions for
2 performing a method, the method comprising:
3 accessing stored volumetric (3D) imaging data of a subject;
4 initializing at least one parameter of a volumetric segmentation algorithm;
5 iteratively performing a segmentation to separate 3D tubular structure data
6 from other data in the 3D imaging data, the iteratively performing the segmentation
7 including iterating the segmentation algorithm; and
8 reinitializing the at least one parameter between iterations of the
9 segmentation algorithm, the reinitializing including adjusting the at least one
10 parameter if needed to accommodate a local variation in the 3D tubular structure
11 data.
- 1 **22.** A computer-assisted method of performing a segmentation of 3D tubular
2 structure data from other data in 3D imaging data, the method comprising:
3 initializing a wave-like front at an origin that is located along a path of
4 interest in the 3D imaging data;
5 initializing a propagation speed of evolution of the front to a first value;

6 propagating the front by iteratively updating the front, the updating
7 including recalculating the propagation speed;
8 comparing the propagation speed to a predetermined threshold value that is
9 less than the first value;
10 if the propagation speed falls below the predetermined threshold value, then
11 terminating the propagating of the front; and
12 classifying all points that the front has reached as pertaining to the tubular
13 structure.

1 23. The method of claim 22, further comprising constraining the front to prevent
2 propagation beyond a predetermined distance from the origin.

1 24. The method of claim 22, further comprising receiving user input to specify a
2 single location as the origin.

1 25. The method of claim 22, further comprising determining the path of interest
2 using an atlas of stored 3D human body imaging information.

1 26. The method of claim 22, further comprising:
2 initializing at least one parameter associated with the front;
3 iteratively propagating the front until a termination criterion is met; and
4 reinitializing the at least one parameter between the iterations, the
5 reinitializing including adjusting the at least one parameter to accommodate a local
6 variation in data associated with the tubular structure.

1 27. A computer readable medium including executable instructions for
2 performing a method, the method comprising:
3 initializing a wave-like front at an origin that is located along a path of
4 interest in the 3D imaging data;
5 initializing a propagation speed of evolution of the front to a first value;

6 propagating the front by iteratively updating the front, the updating
7 including recalculating the propagation speed;
8 comparing the propagation speed to a predetermined threshold value that is
9 less than the first value;
10 if the propagation speed falls below the predetermined threshold value, then
11 terminating the propagating of the front; and
12 classifying all points that the front has reached as pertaining to the tubular
13 structure.

1 **28.** A computer-assisted method comprising:
2 obtaining volumetric three dimensional (3D) imaging data of a subject;
3 computing a central vessel axis (CVA) of at least one vessel of interest;
4 performing a segmentation to separate data associated with the at least one
5 vessel of interest from other data in the 3D imaging data of the subject to obtain
6 segmented data that is associated with a segmented vessel structure;
7 representing a 3D image of a region of the 3D imaging data on a two
8 dimensional (2D) screen;
9 displaying on the screen a first lateral view of at least one portion of the at
10 least one vessel of interest;
11 displaying on the screen a second lateral view of the at least one portion of
12 the at least one vessel of interest, the second lateral view taken perpendicular to the
13 first lateral view; and
14 displaying on the screen cross sections, perpendicular to the CVA; and
15 wherein the 3D image, the first and second lateral views, and the cross
16 sections are displayed in visual correspondence together on the screen.

1 **29.** The method of claim 28, further comprising obtaining the first lateral view
2 by performing curved planar reformation on the CVA of the segmented vessel
3 structure.

1 **30.** The method of claim **28**, further comprising choosing a direction of the first
2 lateral view to obtain a substantial minimum of curvature of the vessel of interest in
3 an elongated window displaying the first lateral view.

1 **31.** The method of claim **30**, in which the choosing the direction includes
2 performing Principal Components Analysis (PCA).

1 **32.** The method of claim **28**, further comprising receiving user input specifying a
2 single location as an origin for at least one of the computing the CVA and the
3 performing the segmentation.

1 **33.** The method of claim **28**, further comprising specifying the at least one
2 vessel of interest using an atlas of stored 3D human body imaging information.

1 **34.** The method of claim **28**, in which the performing the segmentation includes:
2 initializing at least one parameter of a segmentation algorithm;
3 iteratively performing the segmentation to separate data associated with a 3D
4 tubular structure from other data in the 3D imaging data, the iteratively performing
5 the segmentation including iterating the segmentation algorithm; and
6 reinitializing the at least one parameter between iterations of the
7 segmentation algorithm, the reinitializing including adjusting the at least one
8 parameter to accommodate a local variation in data associated with the tubular
9 structure.

1 **35.** The method of claim **28**, in which the performing the segmentation
2 comprises:
3 initializing a wave-like front at an origin that is located along the CVA;
4 initializing a propagation speed of evolution of the front to a first value;
5 propagating the front by iteratively updating the front, the updating
6 including recalculating the propagation speed;

7 comparing the propagation speed to a predetermined threshold value that is
8 less than the first value;
9 if the propagation speed falls below the predetermined threshold value, then
10 terminating the propagating of the front; and
11 classifying all points that the front has reached as pertaining to the tubular
12 structure.

1 **36.** The method of claim **28**, further comprising masking data that is outside of
2 the vessel of interest.

1 **37.** The method of claim **28**, further comprising computing at least one
2 estimated diameter of the segmented vessel of interest.

1 **38.** The method of claim **37**, further comprising flagging at least one location of
2 the segmented vessel of interest, the at least one location deemed to exhibit at least
3 one of a stenosis or an aneurysm.

1 **39.** The method of claim **37**, further comprising displaying the segmented vessel
2 of interest using a color-coding to indicate the diameter.

1 **40.** The method of claim **28**, further comprising displaying the segmented vessel
2 of interest in a manner that mimics a conventional angiogram.

1 **41.** The method of claim **28**, in which the displaying on the screen cross sections
2 includes displaying an array of cross-sections that are equally spaced apart on the
3 CVA.

1 **42.** The method of claim **41**, further comprising:
2 displaying a cursor that is manipulable to travel along a view of the vessel of
3 interest; and

4 in which the array of cross-sections is centered around a location of the
5 cursor.

1 43. A computer readable medium including executable instructions for
2 performing a method, the method comprising:
3 obtaining volumetric three dimensional (3D) imaging data of a subject;
4 computing a central vessel axis (CVA) of at least one vessel of interest;
5 performing a segmentation to separate data associated with the at least one
6 vessel of interest from other data in the 3D imaging data of the subject to obtain
7 segmented data that is associated with a segmented vessel structure;
8 representing a 3D image of a region of the 3D imaging data on a two
9 dimensional (2D) screen;
10 displaying on the screen a first lateral view of at least one portion of the at
11 least one vessel of interest;
12 displaying on the screen a second lateral view of the at least one portion of
13 the at least one vessel of interest, the second lateral view taken perpendicular to the
14 first lateral view; and
15 displaying on the screen cross sections, perpendicular to the CVA; and
16 wherein the 3D image, the first and second lateral views, and the cross
17 sections are displayed in visual correspondence together on the screen.